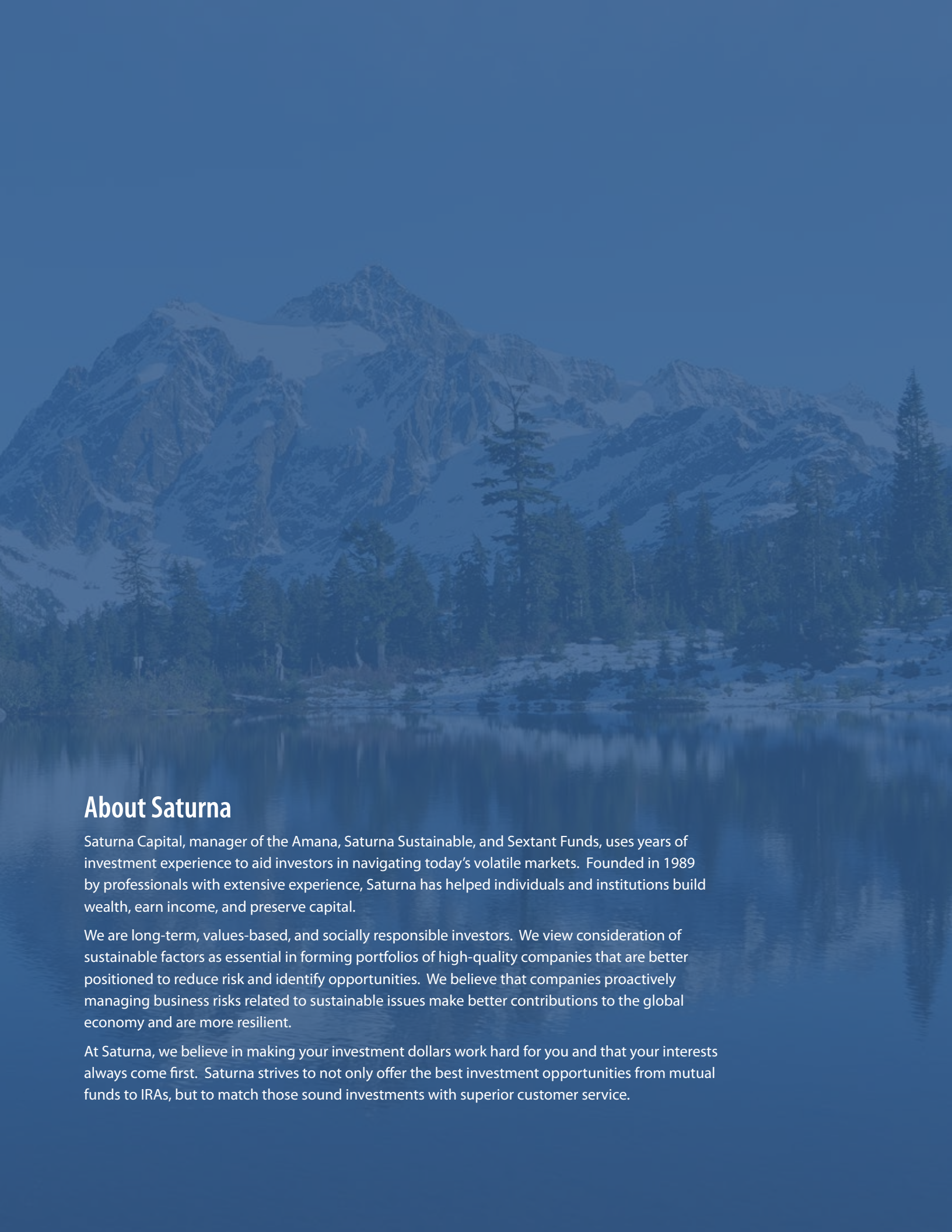
Renewable Energy: Supply and Demand in Constructing a Low-Carbon Economy

From The
YARDARM
Market Commentary & Analysis

July 2024



About Saturna

Saturna Capital, manager of the Amana, Saturna Sustainable, and Sextant Funds, uses years of investment experience to aid investors in navigating today's volatile markets. Founded in 1989 by professionals with extensive experience, Saturna has helped individuals and institutions build wealth, earn income, and preserve capital.

We are long-term, values-based, and socially responsible investors. We view consideration of sustainable factors as essential in forming portfolios of high-quality companies that are better positioned to reduce risk and identify opportunities. We believe that companies proactively managing business risks related to sustainable issues make better contributions to the global economy and are more resilient.

At Saturna, we believe in making your investment dollars work hard for you and that your interests always come first. Saturna strives to not only offer the best investment opportunities from mutual funds to IRAs, but to match those sound investments with superior customer service.

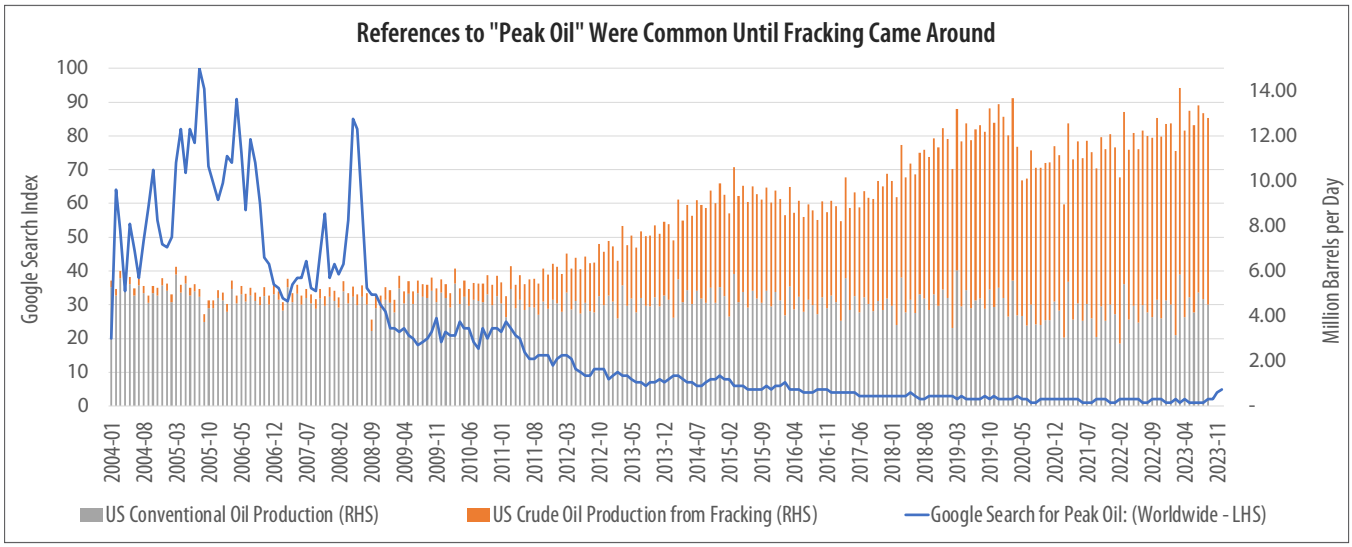
This is Part Two of a three-part series about the transition to a low-carbon economy by way of electrification, one of the most important strategies for reducing global carbon emissions. Part Two includes:

- **How the use of green metals is vital to reaching net-zero carbon emissions.**
- **Potential risks and challenges to the markets of different types of green metals.**
- **The role that materials and mining, a high-carbon sector, plays in the transition to a low-carbon economy.**

The energy transition boils down to moving from a fossil-fueled economy to one energized through metals and materials. The metal-intensity of the transition, long mine development lead times, high capital intensity, and price volatility are likely to lead to bottlenecks. Meanwhile, new processes or technologies could upend market expectations.

Supply/demand dynamics are fundamental to every industry, but especially for commodities. As the market works to find a balance, three potential scenarios could unfold:

1. Demand causes prices to rise, encouraging supply expansion similar to the US fracking boom in the late-aughts and 2010s, but with evolving direct lithium extraction (DLE) techniques.
2. Price increases lead to either material or technological substitution. For example, cheaper lithium iron phosphate (LFP) batteries are now a common substitute for expensive cobalt-dependent batteries.
3. High prices lead to end-product demand destruction, undermining the transition to a low-carbon economy.

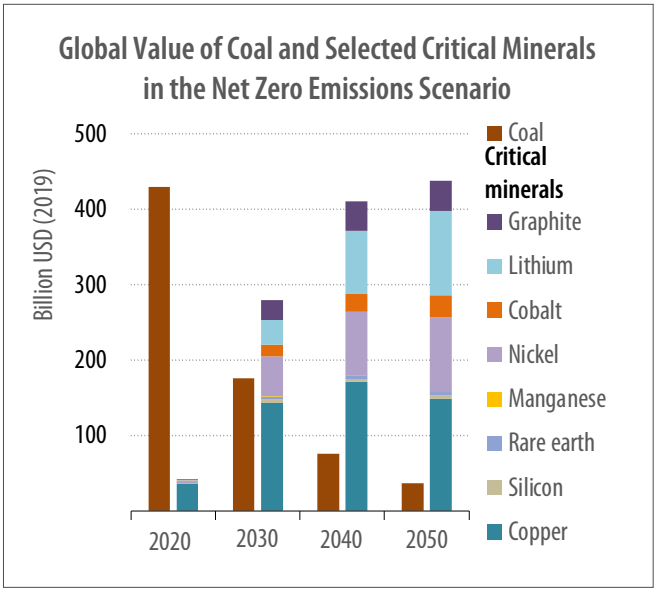


Source: US Energy Information Agency (EIA), Google, Saturna Capital Research

To meet net-zero targets, metals and mining require more than $2 trillion in investments.[1] Miners that successfully navigate these various scenarios stand to be major beneficiaries of the transition. One must deconstruct the supply/demand dynamics to better understand which types of metals have the most attractive investment characteristics.

Demand Drivers

Many analysts have noted we are in a new commodity "supercycle," driven by efforts to fight climate change. The previous supercycle lasted from 2000 to 2014, driven by Chinese growth. As the world transitions to a low-carbon economy, demand for green metals will need to increase seven-fold by 2030, at which point revenues from these metals are expected to exceed those of coal.

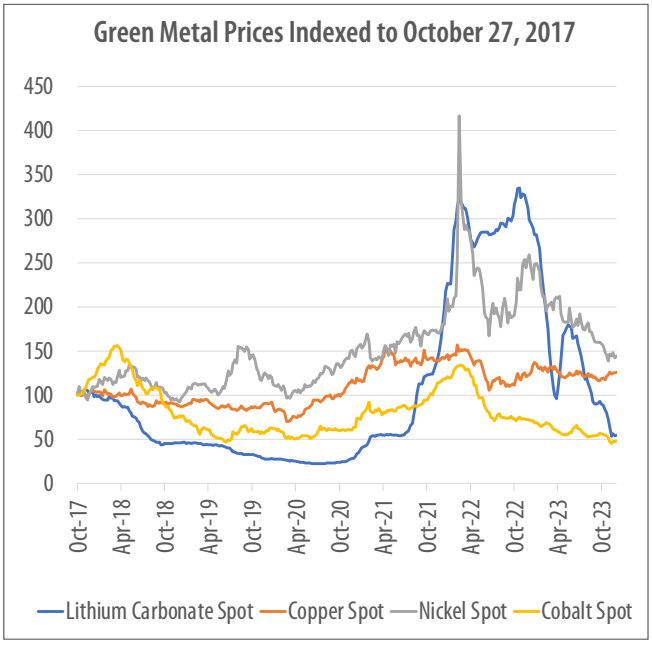


Source: International Energy Agency (IEA) and Saturna Capital Research

While copper has the largest market across green metals, lithium and cobalt are expected to experience the fastest growth. Cobalt, unlike lithium, has numerous substitutes such as nickel, and those substitutes could undermine these expectations. Cobalt is expensive and supply is concentrated in the Democratic Republic of Congo (DRC) and Russia, leading many manufacturers to seek alternatives. Similarly, graphite is expected to see massive growth, but faces substitution risk from graphene and silicon. Each of these substitutes are actively being pursued as battery developers look to increase electric vehicle (EV) range and lower charge times.

Supply Characteristics

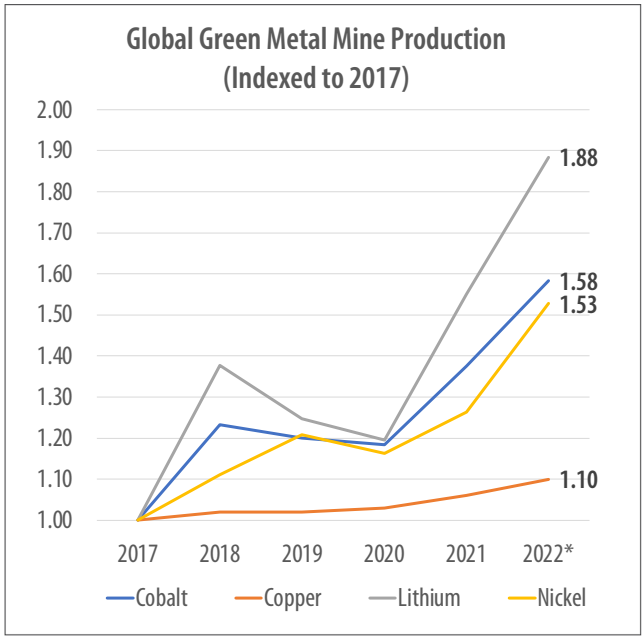
Except for copper, most green metals had little prior industrial use and (until recently) lacked adequate investment. The torrid uptick in renewable energy projects and EV demand exposed volatility in smaller and more nascent commodity markets. Here, the trite commodity adage "the cure for high prices is high prices" holds once again.



Source: Refinitiv, Saturna Capital Research

The rapid increase in lithium, nickel, and cobalt prices from 2020 to 2022 spurred an increase in production, as the adage implied. This ramp in production led prices to plummet in 2023. Against these smaller markets, copper's

lower volatility stands out. Copper has been used for over ten thousand years. Its extensive and procyclical use led to the term "Dr. Copper – the metal with a PhD in economics." The combination of long-running use and diversified demand support copper's relative stability in recent years. However, this stability could change as limited substitutes, diminishing resource quality, and a 17-year average lead time from discovery to production suggest copper could be a critical bottleneck in the energy transition.[2]

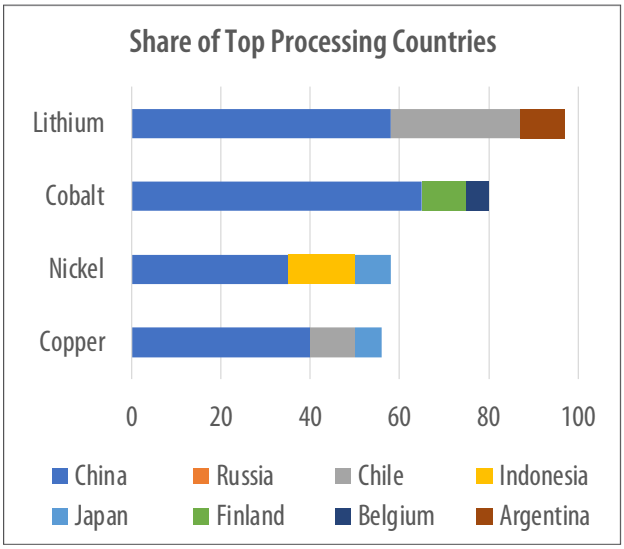


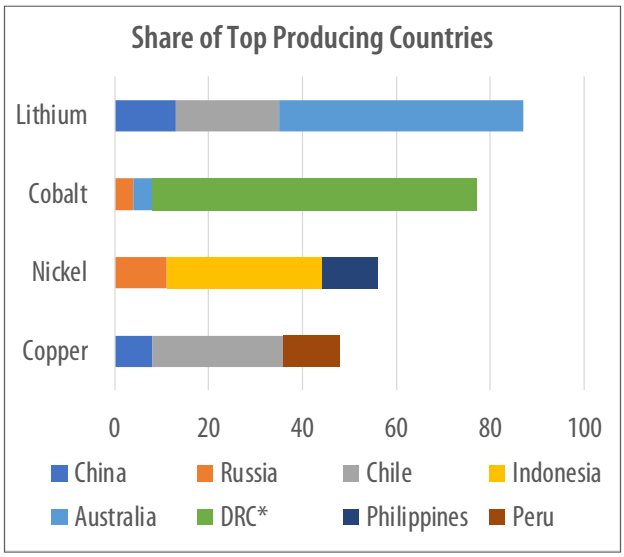
Source: US Geological Survey, Saturna Capital Research

As of writing, elements of the first two scenarios have played out. High prices spurred both expanded supply and materials substitution. However, end-product demand destruction has not materialized. Although surging demand drove high commodity prices in 2021 and 2022, materials substitution and improved manufacturing productivity supported largely flat lithium-ion battery pack prices from 2020 to 2022. Meanwhile, continued improvements and substitutions, along with falling metal costs, led battery prices to reach an all-time low in 2023.[3] Despite recent media attention, EV sales growth remains strong and, while still plausible, demand destruction looks less likely.

Geopolitical Risks

Disruption from geopolitical events is more likely than the demand destruction mentioned above. While the US stands as the world's largest oil producer, countries featuring poor





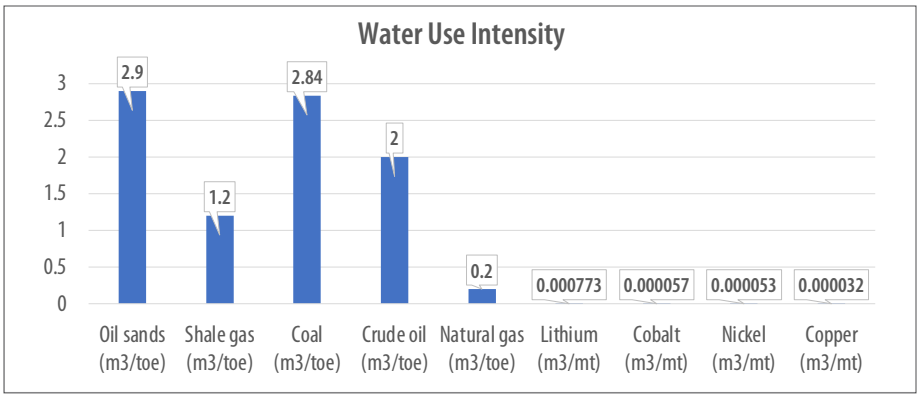
Source: IEA, Saturna Capital Research
**Democratic Republic of Congo (DRC)*

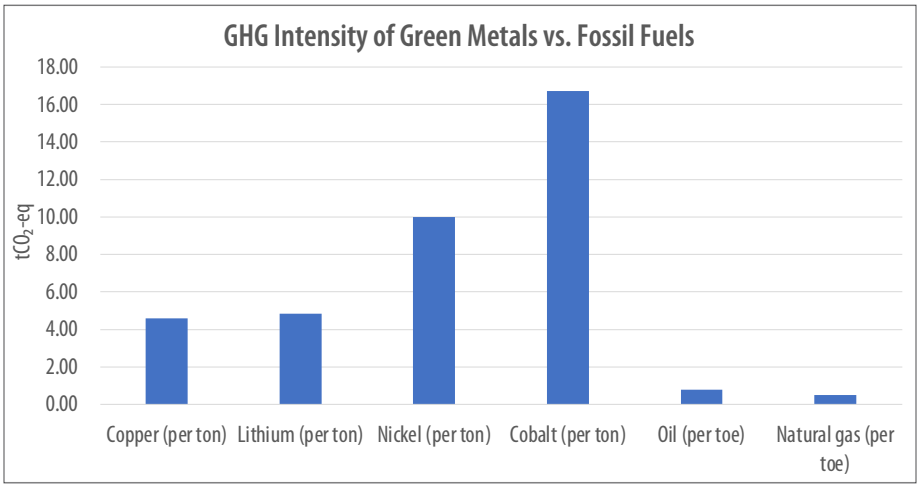
governance dominate the production and processing of green metals. Fortunately, reserves are more broadly distributed, with Australia standing out as a likely winner. Already the largest lithium producer, Australia is tied with Indonesia for the largest nickel reserves (22% of global reserves) and has 20% of global cobalt reserves.

Despite the potential for future diversification, current and announced projects indicate no imminent shift. According to The Economist, half of all production of green metals in 2040 is expected to occur in autocracies.[4] The concentration of resources in poorly governed countries makes understanding local and geopolitics fundamental to assessing investment opportunities.

Environmental and Social Risks

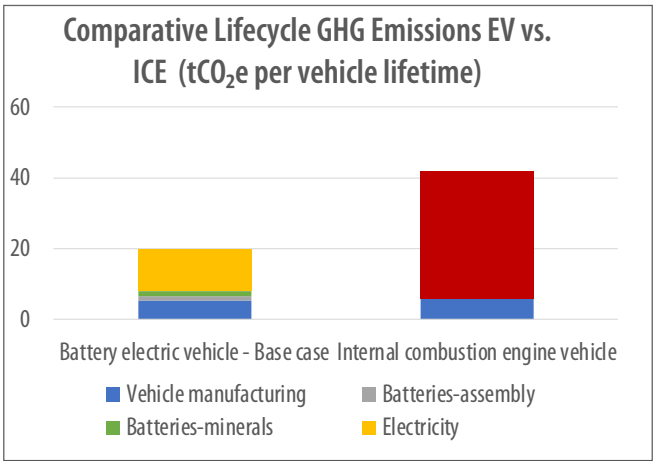
Apart from geopolitical and governance concerns, mining presents an environmental and social conundrum. Sustainability-focused investors have shunned the Materials and Mining sector for its deleterious effects on employees, local societies, and environments. But how do we address climate change without it? Greenhouse gas (GHG) emissions from mining and refining various metals needed in the transition illustrate the paradox. Additionally, water use presents a major environmental risk. While these metals are far less water-intensive than fossil fuels, water scarcity remains an important consideration, as areas of high water stress account for approximately half of global lithium and copper production.[5]





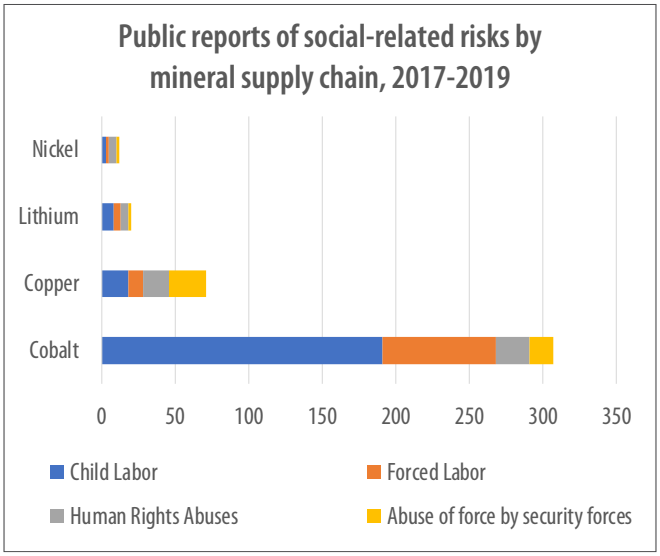
Sources: IEA and Saturna Capital Research
toe – ton of oil equivalent; mt – metric ton; ton – ton of metal equivalent

To be sure, these figures don't consider several important differences between the use of metals and fossil fuels. Unlike metals, fossil fuels are consumed in energy production. Speaking to this, the average American consumes nearly three tons of oil per year.[6] For comparison, US per capita copper consumption is only 13 pounds.[7] Lifecycle emissions of EVs versus their internal combustion engine (ICE) counterparts provide another important data point. While total emissions depend on electricity source and usage, a base case estimate shows EVs release less than half the lifetime emissions relative to ICE vehicles. Add to this the fact that metals can be recycled several times over, and it becomes clear green metals are less harmful to the environment.



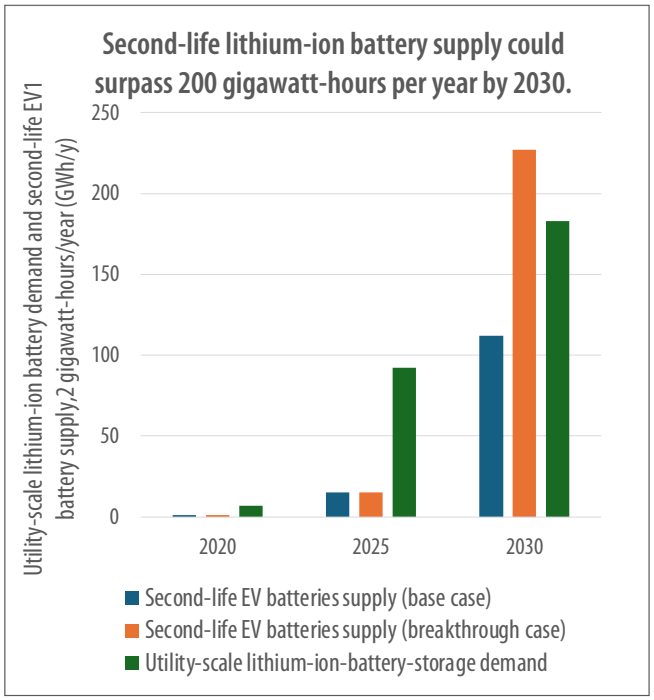
Sources: IEA and Saturna Capital Research

Mining, along with its effects on local environments, has a history of social challenges. In many ways, mining presents a case study for why ESG matters. All mining companies must uphold a social license to operate. However, governments often grant miners public lands for their operations; therefore, the need to maintain this license is clearly fundamental to the sector. As shown in "Public reports of social-related risks by material supply chain, 2017-2019," social risks vary widely by metal, but cobalt stands out for its heightened exposure. While copper, too, has a higher number of reports, its market is several times larger than the other green metals. To address ESG concerns, miners have substantially increased the attention they give to these risks over the past five years, with many discussing strategies and performance on quarterly and semi-annual earnings calls.



Sources: IEA and Saturna Capital Research

Batteries and the mining of battery materials is one of the dirtiest aspects of the transition to a low-carbon economy. Beyond the environmental degradation and social repercussions often associated with mining rare earth minerals, the processing of these metals is also carbon intensive. The recovery of metals that can be endlessly recycled, such as cobalt, lithium, and nickel, is a promising avenue to addressing this aspect. According to a 2019 World Economic Forum study, "a circular battery value chain" could provide 20% of the emissions cuts called for in the Paris Accord while creating 10 million sustainable jobs globally by 2030.[8]



Sources: McKinsey

In an article from 2021, Bloomberg New Energy Finance (BNEF) estimated that by 2030, EVs alone will produce roughly 1.7 million metric tons of scrapped batteries. BNEF further estimated that recycling these materials could address 10% of the forecast battery demand in 2030.[9] This would increase over time as the EV vehicle stock ages. Another option for EV batteries is to repurpose depleted batteries for grid storage. Once an EV battery dips below utilizing 80% of its capacity, it is no longer fit for use in an EV. This same battery is still useful for some applications in grid storage, such as shorter duration "peaking" discharges, where energy density demands are less. McKinsey estimates that these second-life batteries are 30-70% less expensive than new ones for such applications.

Concluding Thoughts

The transition to a low-carbon economy requires multiple metals and materials, but two stand out for their risk-reward profile. Lithium, with its limited historical use cases, should see massive growth while benefiting from limited substitutes. Its main risk is that new forms of processing could drastically increase the supply. Copper, on the other hand, has been used for millennia and its resources continue to degrade. This, combined with long lead times for mine developments, makes oversupply less of a long-term concern. On the other hand, copper has benefited from widespread industrial growth in China, and faltering demand could be a risk. While commodities are notoriously volatile and they present a potential bottleneck to decarbonization, copper and lithium's burgeoning role in powering global economies provides a compelling long-term opportunity.

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Levi Zurbrugg CFA®, joined Saturna in June 2019. He graduated from Western Washington University with a BA in Business Administration and has an MBA from the University of Washington's Foster School of Business. Prior to Saturna, Mr. Zurbrugg worked at the Sustainability Accounting Standards Board as a Sector Analyst for the Consumer Staples sector. He is a Certified Public Accountant and Chartered Financial Analyst (CFA®) charterholder. Outside of work, Mr. Zurbrugg enjoys exploring the outdoors via foot, skis, and bikes with his wife and son.

Footnotes

[1] *Hume, Neil. "Bigger investment in mining needed to meet climate goals, says LGIM." Financial Times, April 5, 2022. https://www.ft.com/content/eed5d758-2d3c-4723-a1b1-666d82660af1*

[2] *IEA. "Average observed lead times from discovery to production for selected minerals, 2010-2019." IEA, Paris https://www.iea.org/data-and-statistics/charts/average-observed-lead-times-from-discovery-to-production-for-selected-minerals-2010-2019*

[3] *"Lithium-Ion Battery Pack Prices Hit Record Low of $139/kWh." Bloomberg NEF, November 26, 2023. https://about.bnef.com/blog/lithium-ion-battery-pack-prices-hit-record-low-of-139-kwh/#:~:text=For%20battery%20electric%20vehicle%20(BEV,of%20the%20total%20pack%20price.*

[4] *"The transition to clean energy will mint new commodity superpowers." The Economist, March 26, 2022. https://www.economist.com/finance-and-economics/2022/03/26/the-transition-to-clean-energy-will-mint-new-commodity-superpowers*

[5] *"International Energy Agency, "The Role of Critical Minerals in Clean Energy Transitions." World Energy Outlook Special Report, May 2021. https://iea.blob.core.windows.net/assets/ffd2a83b-8c30-4e9d-980a-52b6d9a86fdc/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf*

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[7] *"U.S. consumption of copper per capita 2019-2022." Statista Research Department, October 30, 2023. https://www.statista.com/statistics/1346760/us-copper-consumption-per-capita/#:~:text=Copper%20consumption%20per%20capita%20in,and%20household%20applications%2C%20among%20others.*

[8] *Insight Report: A Vision for a Sustainable Battery Value Chain in 2030; Unlocking the Full Potential to Power Sustainable Development and Climate Change Mitigation. World Economic Forum, September 2019. http://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf*

[9] *Stock, Kyle. "Old EV Batteries Look Like a Gold Mine for Dogged Entrepreneurs." Bloomberg News, January 21, 2021. https://www.bloomberg.com/news/articles/2021-01-21/old-ev-batteries-look-like-a-gold-mine-for-dogged-entrepreneurs*

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Green materials is a term used to describe a set of materials that are utilized in clean energy applications and can help achieve net zero emissions targets. These materials include graphite, graphene, and silicon.

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